INJECTOR

[0001] The invention relates to an injector for a common rail injection system having the characteristics recited in the preamble to claim 1.

[0002] Prior Art

[0003] Common rail injection systems have a plurality of injectors, which under the control of an electronic motor controller are supplied with fuel by a high-pressure pump from a central high-pressure reservoir known as a common rail and inject the fuel into the combustion chambers of the engine.

[0004] From German Patent Disclosure DE 100 20 870 A1 of the present Applicant, a common rail injector is already known whose injector housing contains a valve element that is inserted into a stepped bore in the injector housing and is sealed from the injector housing by a soft sealing ring, which serves as a seal between a high-pressure region and a low-pressure region of the injector. The sealing ring is inserted into an annular chamber above an annular shoulder of the stepped bore and is braced against the annular shoulder. To prevent the sealing ring from being pressed or extruded into a narrow annular gap, located below the annular shoulder, between the valve element and the injector housing as a result of the varying fuel pressures of up to 1900 bar that prevail in the high-pressure region of above the sealing ring, a metal support ring is disposed between the sealing ring and the annular shoulder. Since at the aforementioned pressures complete tightness of the sealing ring cannot be assured, the support ring, on its underside toward the annular shoulder, is provided with a

total of four shallow leak fuel or relief grooves, which furnish a defined lack of tightness between the support ring and the injector housing so as to carry away a leak fuel flow moving past the sealing ring and thus prevent the buildup of a pressure cushion below the sealing ring, which could lead to an unwanted axial displacement of the sealing ring.

[0005] Since in injectors for common rail injection systems currently being mass produced by the present Applicant, the support ring furthermore rests sealingly with its outer circumferential edge against the adjacent inner wall of the stepped bore, it furthermore has, adjacent to one another in the axial direction on each relief groove, a crescent-shaped indentation recessed out of its outer circumferential edge, which is meant to allow the leak fuel flow to pass between the outer circumferential edge of the support ring and the adjacent inner wall of the stepped bore into the relief grooves. With such an arrangement, however, an unwanted extrusion of the sealing ring material through the recesses and the relief grooves could occur, so that the sealing function of the sealing ring could no longer be assured and consequently failure of the entire injection system could be brought about.

[0006] Advantages of the Invention

[0007] The injector of the invention having the characteristics recited in claim 1 offers the advantage over the prior art that the existing short path through the recesses and relief grooves can be lengthened because of the offset of the recesses and relief grooves, and as a result the frictional forces which counteract an extrusion of the sealing ring material through the recesses and relief grooves can be increased considerably. In other words, the existing direct path is blocked, and a detour is created, which in combination with the small flow cross

sections in the region of the detour, in other words between a recess and the adjacent relief groove, counteracts extrusion of the sealing ring material. The passage of the leak fuel flow continues to remain assured, and at the same time its flow velocity is advantageously reduced by the offset arrangement in the circumferential direction of the relief grooves and recesses. The injector of the invention furthermore has a support ring of sturdy construction, since the weakening zones formed by the relief grooves and the recesses do not coincide, and excessive motions in the region of the recesses, which are suspected to be one of the causes for extrusion of the sealing ring material, are avoided.

[0008] By the disposition of the recesses and relief grooves in accordance with the invention, the support ring has a material thickness in the region of the recesses that is greater, by the groove depth of the relief grooves, compared to the prior art. As a result, the lower edges of the recesses come closer to the housing wall of the injector, which in turn in this region results in smaller gap cross sections, which also counteract any extrusion.

[0009] In a preferred feature of the invention, it is provided that the relief grooves and the recesses are offset from one another in such a way that one recess each is located between two relief grooves adjacent to one another in the circumferential direction, while conversely, one relief groove each is disposed between two recesses adjacent to one another in the circumferential direction, in both cases preferably in the middle.

[0010] A further preferred feature of the invention provides that the support ring, as before, has a total of four recesses, disposed at a spacing of 90° in the circumferential direction, and four relief grooves, also disposed at a spacing of 90° in the circumferential direction, in order

to assure an adequate flow cross section for the leak fuel flow, but that the relief grooves are disposed at an angular spacing of 45° from the recesses, and vice versa, in order to create the longest possible detours between adjacent relief grooves and recesses.

[0011] The relief grooves, impressed into the support ring, preferably in the form of rounded crescents, expediently have a depth of from 0.05 to 0.1 mm, while the recesses expediently have a crescent-shaped cross section and a depth of from 0.12 to 0.17 mm and are stamped out of the support ring.

[0012] In a further preferred feature of the invention, the cross-sectional shape of the annular shoulder of the stepped bore and the cross-sectional shape of the support ring are advantageously adapted to one another in such a way that the support ring, between the recesses, rests with its outer circumferential edge essentially sealingly against a part, located above the annular shoulder, of the inner wall of the stepped bore and, between the relief grooves, rests with parts of its underside sealingly against the annular shoulder of the stepped bore. These parts of the underside that rest sealingly against the annular shoulder preferably border on the valve element and do not extend over the full width of the support ring, so that flow conduits extending radially outward from the sealingly contacting parts between the annular shoulder and the underside of the support ring in its circumferential direction remain open with a small flow cross section and establish a communication between the recesses and relief grooves. The flow conduits are preferably embodied in the underside of the support ring, but they may also be embodied as an annular groove in the annular shoulder. The flow cross section of these flow conduits is expediently essentially equivalent to that of the relief grooves and the recesses.

[0013] Drawings

[0014] The invention will be described in further detail below in terms of an exemplary embodiment in conjunction with the associated drawings. Shown are:

[0015] Fig. 1, a longitudinal sectional view, partly cut away, through an injector of the invention with a support ring;

[0016] Fig. 2, a top view, partly cut away, of the support ring of Fig. 1;

[0017] Fig. 3, a cross-sectional view of the support ring along the line III-III of Fig. 2;

[0018] Fig. 4, a cross-sectional view of the injector along the line IV-IV of Fig. 1;

[0019] Fig. 5, an enlarged view of detail V of Fig. 1.

[0020] Description of the Exemplary Embodiment

[0021] The injector 2, shown partially in Fig. 1 of the drawing, for a common rail injection system of an internal combustion engine serves to inject fuel from a central high-pressure reservoir, known as a common rail, into the combustion chambers of the engine.

[0022] The complete construction of such an injector has been described at length, for instance in German Patent Disclosures DE 196 19 523 A1 and DE 102 20 457 A1 of the present Applicant and will therefore not be explained further at this point.

[0023] As best seen from Fig. 1, the injector 2 includes an injector housing 4 with a stepped bore 6. A valve element 8 is inserted into the stepped bore 6 and serves as a guide for a control rod 10, with which the opening and closing motions of a nozzle needle (not shown) of the injector 2 can be controlled.

[0024] The stepped bore 6 has a widened upper part 12, which is divided by an annular shoulder 14 from a narrowed lower part 16. The inside diameter of the widened upper part 12 of the stepped bore 6 is greater than the outside diameter of the cylindrical valve element 8, so that an annular chamber fluidically communicating with the high-pressure reservoir is formed there around the valve element 8. The inside diameter of the narrowed lower part 16 of the stepped bore 6 is only slightly greater than the outside diameter of the cylindrical valve element 8, so the narrow sealing gap 20 is formed there around the valve element 8.

[0025] To prevent fuel from the high-pressure region, formed among other elements by the annular chamber 18, from flowing past the annular shoulder 14 into a low-pressure region formed by the gap 20, among other elements, the lower end of the annular chamber 18 is sealed off by a high-pressure sealing ring 22, which comprises a mixture of polytetrafluoroethylene (PTFE) and bronze powder. To prevent the sealing ring 22, in response to the changing pressures prevailing in the annular chamber of up to approximately

1700 bar, from being extruded into the sealing gap 20, a support ring 24 which is braced on the annular shoulder 14 is disposed below the sealing ring 22.

[0026] As best seen in Figs. 1, 3 and 5, the one-piece sealing ring 22 made of C60 sheet steel has an angled cross-sectional shape, which comprises a short inner support ring part 26, which in a press fit contacts the valve element 8, and an outer support ring part 30, resting with its outer circumferential edge 28 in a press fit against the inner wall of the widened part 12 of the stepped bore 6, the support ring parts being joined by a rounded transition 32.

[0027] To prevent a fuel pressure cushion from building up below the sealing ring 22 when fuel moves downward past the sealing ring 22, which can cause the sealing ring 22 to be displaced upward away from the annular shoulder 15 so that it can no longer perform its sealing function, flow conduits are provided in the support ring 24; they permit slight quantities of fuel to flow past into the sealing gap 20.

[0028] These flow conduits comprise four crescent-shaped recesses 34 in the outermost circumferential edge of the outer support ring part 30 and four radial relief grooves 36 in its underside, which recesses and relief grooves are in fluidic communication with one another. The recesses 34 and the relief grooves 36 are each disposed at equal spacings of 90° around the circumference of the support ring 24, but are offset from one another in the circumferential direction by 45°, in order to prevent an extrusion of the sealing ring material through the flow conduits. The fluidic communication between the recesses 34 and the respective adjacent relief grooves 36 is established by means of the angled form of the support ring 24, which is best seen from Fig. 5. This support ring rests against the annular

shoulder 14 only in the region of the transition between the support ring part 26 and the support ring part 30, while the two support ring parts 26 and 30 are oriented obliquely to the annular shoulder 14; the outer support ring part 30 is braced with its outer circumferential edge 28 on the upper end of a transition radius 46, which for reasons of strength is provided between the upper part 12 of the stepped bore 6 and the annular shoulder 14. As a result, below the support ring part 30, an annular interstice 38 is formed, through which fuel from the recesses 34 can reach the relief grooves 36.

[0029] The axial recesses 34 have a crescent-shaped cross section with a maximum depth T (Fig. 4) of approximately 0.12 to 0.17 mm and in the production of the support ring 24 they are stamped out of the radial support ring part 30.

[0030] The radial relief grooves 36, with a depth of from 0.05 to 0.1 mm, are formed by crescents 40 of a rounded cross section, which in the production of the support ring 24 are impressed from below into the radial support ring part 30 and which extend over the entire width of the support ring part 30 (Fig. 4).

[0031] As best shown in Fig. 4, between the four recesses 34, each support ring 24 rests sealingly with its outer circumferential edge 28 against the inner wall of the widened part 12 of the stepped bore 6, while between the four relief grooves 36, with an inner, annular-segment-shaped part 42 of its underside shown in shaded lines and bordering on the valve element 8, each support ring rests sealingly on the part of the annular shoulder 14 that is located radially inward from the annular groove 38.

[0032] As indicated by the arrow A in Fig. 4, the leak fuel flow downward past the sealing ring 22 until it reaches the top side of the support ring 24 passes through the recesses 34 between the support ring 24 and the inner wall of the widened part 12 of the stepped bore 6 and from there flows in the circumferential direction through the shallow annular groove 38 as far as one of the two adjacent relief grooves 36, through which it then flows radially inward into the gap 20 between the valve element 8 and the injector housing 4, from which place it is carried away. The direct short path to the inside represented by the arrow B is blocked, so that because of the detour, an extrusion of the sealing ring material through the recesses 34 and relief grooves 36 is reliably avoided.